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Patentanmeldung Nr. | Patent application No. | Demande de brevet n°

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Bezeichnung der Erfindung/Title of the invention/Titre de l'invention:
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Key block storage on R or RW media

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Key block storage on R or RW media

The invention as described in this patent application relates to a method to distribute a key block through blank recordable media for use in copy protection systems based on such a key block, a record carrier comprising such a key block, an apparatus for reading out such a record carrier and a copy-protection system employing such a KB.

Introduction

Modern systems for protecting content which may be copied onto recordable media, but only so under certain strict conditions e.g. copy-once material, or broadcast content protected by the so called broadcast flag. are almost all based on a so called Key Block (KB).

Examples of such a system are the CPRM (Copy Protection for Recordable Media) system for DVD-RW, DVD-R, DVD-RAM and the CPPM (Copy Protection for Pre-recorded Media) system for pre-recorded media (see http://www.4centity.org).

Key blocks (KBs) are essentially tables of cryptographic information which are distributed on empty R and RW media with the purpose of rendering revoked players and recorders inoperable. To that end all players and recorders supporting the content protection system are endowed with device-specific sets of device keys at manufacturing time (so every device has a unique set), and these devices process the KB with their device keys with the purpose of obtaining a common root key K_{root} (also sometimes referred to as the Media key K_m). The KB is prepared in such a way that all regular devices will indeed calculate the same root key, but all the revoked devices (taken out of the system) will obtain some other value. Since the copy protection system standard of which the KB is part mandates that the content is subsequently encrypted (recorder) or decrypted (player) with the root key, this renders the revoked devices useless with these media.

A common problem in the design of these protection systems is to arrange for the storage of a the KB on the blank media. Key blocks can be quite large (100's of kilobytes up to several megabytes). Storage of the KB brings about several issues:

- because of its potential size, the KB is hard to hide. Hiding is important because legacy recorders/players which do not support the copy protection system employing the KB can

have problems with non-hidden KBs: a legacy device might be confused by the presence of KB data where it expects no data or other data; a legacy device might accidentally erase or overwrite the KB, which makes the media useless for subsequent protected recordings which require such KB.

- writing KBs on media implies an extra production steps for the media manufacturer: e.g. pre-writing requires extra recorders, and pre-embossing necessitates additional complicated etching steps. Given that vast majority of content is still unprotected there will be little incentive for the manufacturer to add a KB to the blank media.
- storage of the KB should preferably not require new detection circuitry which is not already present in current recorders/players, i.e. the KB should be readable with a simple firmware change. An unfavorable example is e.g. the storage area of the KB on BD-RE requires a special kind of wobble-detector which is used for no other purpose.

Some examples from the state-of-the art such as CPRM use KB storage methods which suffer from these problems.

Proposed Solutions

Many types of blank media are already endowed with a relatively low data rate channel to store information relevant to for making the recording. E.g. on DVD+R/W media the ADIP (Address in Pre-groove) is a high-frequency phase-modulated wobble which contains address information and (in the lead-in zone only, see Figure 1) parameters to aid the physical recording process for this particular media (laser power, write-strategy, disc manufacturer etc.), Similarly BD-RE and BD-R have a modulated pre-groove. DVD-R and DVD-RW discs have LPP (Land Pre-Pits), sleeper-like indentations carrying this kind of information, and finally DVD-RAM has pre-embossed lead-in zone and sector headers with the same purpose.

These low data-rate channels for storage of address-information and disc-specific parameters usually have space reserved for future extensions. According to our invention, this space is used for storing the KB.

Since the media manufacturer has to create this side-channel anyway, there is hardly any cost-up (other than for a formatter to provide the right KB-data to the side-channel). More specifically it is proposed to put the KB in the side-channel in the data-zone (the data-zone is the part of the disc which is available for the user to store information; the lead-in and lead-out zones are only available to the recorder and player for administrative

purposes). The advantage of storing KBs in the data-zone is that a recorder/player usually only needs information from the side-channel in the lead-in (for calibrating the laser etc.), so:
- the KB-data would not be getting in the way of other future extensions of the standard (e.g. double-layer DVD+R) which need some space in the side-channel in the lead-in
- legacy recorders don't even read the reserved space in the side-channel in the data-area, so no confusion occurs
- legacy recorders cannot accidentally erase/overwrite the side-channel since it is a ROM-like feature on an R/RW disc.

In particular for DVD+R/W we claim the use of the ADIP in the data-area as a location to store Key Blocks necessary for a content-protection system. Further, for DVD-R and DVD-RW discs we claim the use of KBs in the LPPs.

Extension to the Initial Zone

The solution mentioned in the previous section works well for relatively small KBs. However over the lifetime of a copy-protection system it is possible that the KB can grow quite large. A low data-rate side-channel like ADIP will not be convenient in that case because it may have limited space or take too long to retrieve before a recording can start. E.g. on DVD+R/W ADIP can store approx. 500 Kbytes, but uses up the ADIP of the entire disc to store such KB and therefore takes ~1 hour to read at common writing speeds.

As an alternative, in case of large KBs, the invention relates to the fact that on DVD+RW and DVD+R the media-manufacturer pre-write the KB as regular EFMP data in the so called Initial Zone (see the light-gray colored entry in the Table depicted in Figures 2 and 3).

It must be noted that other locations in the lead-in currently unused can be selected to store the KB (such as some sectors of the Control Data Zone). A list of such other less preferred candidates is: Guard Zones 1,2 and 3, Reserved Zones 1,2 and 3, Buffer Zones 1,2 and 3, and Guards; and only DVD+RW only: Reserved Zone 4. For DVD-R/W again the Initial Zone is preferred but also the following candidates exist: Initial Zone, Buffer Zone 1 and 2.

The Pointer in the Initial Zone

It must be noted that the Initial Zone as a storage location is also not completely free of problems: this zone is located at the very inner radius of the disc where writable material is present. Due to the current disc manufacture process the quality of the

material at the very inner- and outer-edges of the disc is not as reliable as away from these edges. So preferably the KB is written as closely as possible towards the end of the Initial Zone, but then the KB's starting location would be KB-length dependent, a number not initially known to a recorder. For that reason, according to the method according to the invention, we propose to introduce a pointer stored in a safe place on the disc. The pointer indicates the location where exactly the KB starts in the Initial Zone (or other zone). Preferably such pointer is written in the ADIP, because recorders need to read the ADIP anyway. This will give disc manufacturers the flexibility to store the key-block where they deem fit.

In a particular embodiment, a value of pointer = 0 can be used to indicate that there is no KB present in the Initial Zone, but that the KB in the ADIP must be used.

Additional Backup of the KB

A disc manufacturer may gain a competitive advantage by putting a given KB not only in a slow side-channel like ADIP (cheap) but also storing a copy of the KB in the Initial Zone (extra writing step in production), even for relatively short KBs. For the higher price-tag such discs will provide faster start-up times because recorders have the option to use the KB from the Initial Zone. In addition this provides greater robustness, because if for some reason the KB in ADIP or Initial Zone is not readable, a backup alternative exists. The presence of such additional can be indicated through a pointer as elucidated in the previous section.

Copying KB to Buffer Zone 2

Both slow side-channels like ADIP and the Initial Zone are convenient ways to distribute the KB to recorders. However players generally have more limited functionality which doesn't require them to be equipped to read from recorder-specific side channels or maintenance zones like the Initial Zone. In other words, although recorders will be able to read and process the KB in these 2 locations, players cannot without extra electronics (to access e.g. ADIP) or mechanically redesigned OPUs (Optical Pick-up Unit, the sledge containing the laser etc. which in players will bump into the disc motor before reaching the Initial Zone).

To avoid this problem we propose that recorders copy (if this hasn't already been done) the KB from either ADIP or Initial Zone (wherever the KB resides) to Buffer Zone 2 (see the dark-gray colored entry in Figures 2 and 3) as normal EFMP-data. All

players can access Buffer Zone 2, which is not used for other purposes right now. Additionally Buffer Zone 2 has the advantage that legacy recorders will not (accidentally) be overwritten if data has already been written to it, nor will such recorders be confused by data already written there. Note that the one exception is the disc-format command which will erase most of the disc, but not the Initial Zone and obviously not the ADIP; in such case the next recorder which writes to the disc can restore the KB to Buffer Zone 2).

The described method, record carrier, apparatus and system according to the invention have several advantages over prior art:

- legacy recorders not compatible with such copy protection system can still use the media, so only a single type of media needs to be sold to consumers for all applications,
- the storage methods of the Key Block are arranged such that after use of the media in legacy recorders, the Key Block is still readable in devices compatible with the copy protection system,
- legacy recorders / players can be modified through a simple firmware upgrade to be able to read the Key Block stored using the disclosed methods,
- the disclosed storage methods of the Key Block are such that they introduce minimal or no additional cost-up in the media manufacturing process.

The invention can be summarized as follows: The invention to a method to distribute a key block through blank recordable media for use in copy protection systems based on such a key block, a record carrier comprising such a key block, an apparatus for reading out such a record carrier and a copy-protection system employing such a KB. Different embodiments of the method according to the invention for storing this key block on a record carrier are given, e.g. relating to the introduction of a pointer stored in a safe place on the record carrier, the pointer indicating the position where the KB starts or to the copying of the key block to another zone present in the lead-in of the record carrier.

CLAIMS:

1. A record carrier comprising a key block for a content protection system in a side-channel already containing data relevant for making recordings, where the side-channel is one ADIP, or other high-frequency grooves, undeep pits (interrupted grooves) LPP, but not pre-embossed data.

2. A DVD+RW or DVD+R record carrier comprising a key block for a content protection system stored in the Initial Zone.

3. A blank recording medium containing a pointer in a fixed location, the pointer providing a reference to another location where a key block will be stored or is stored, the pointer for example being stored in ADIP, LPP, pre-embossed area or other side-channel present on the recording medium.

4. A recording medium with a KB stored in a recording-relevant side-channel, also containing a reference to a second location where a backup copy of such KB is stored.

5. A copy-protection system employing a KB, where the KB resides in a location which is not accessible to all players, wherein a recorder compatible with such copy-protection system copies the KB from such inaccessible location to a player accessible location, such as Buffer Zone 2 on a DVD record carrier.

6. A method to distribute a key block through blank recordable media for use in copy protection systems based on such a key block.

7. A record carrier comprising a key block stored according to method substantially as described herein before.

8. An apparatus for reading out a record carrier comprising a key block stored according to method substantially as described herein before.

ABSTRACT:

The invention to a method to distribute a key block through blank recordable media for use in copy protection systems based on such a key block, a record carrier comprising such a key block, an apparatus for reading out such a record carrier and a copy-protection system employing such a KB.

Different embodiments of the method according to the invention for storing this key block on a record carrier are given, e.g. relating to the introduction of a pointer stored in a safe place on the record carrier, the pointer indicating the position where the KB starts or to the copying of the key block to another zone present in the lead-in of the record carrier.

Fig. 1

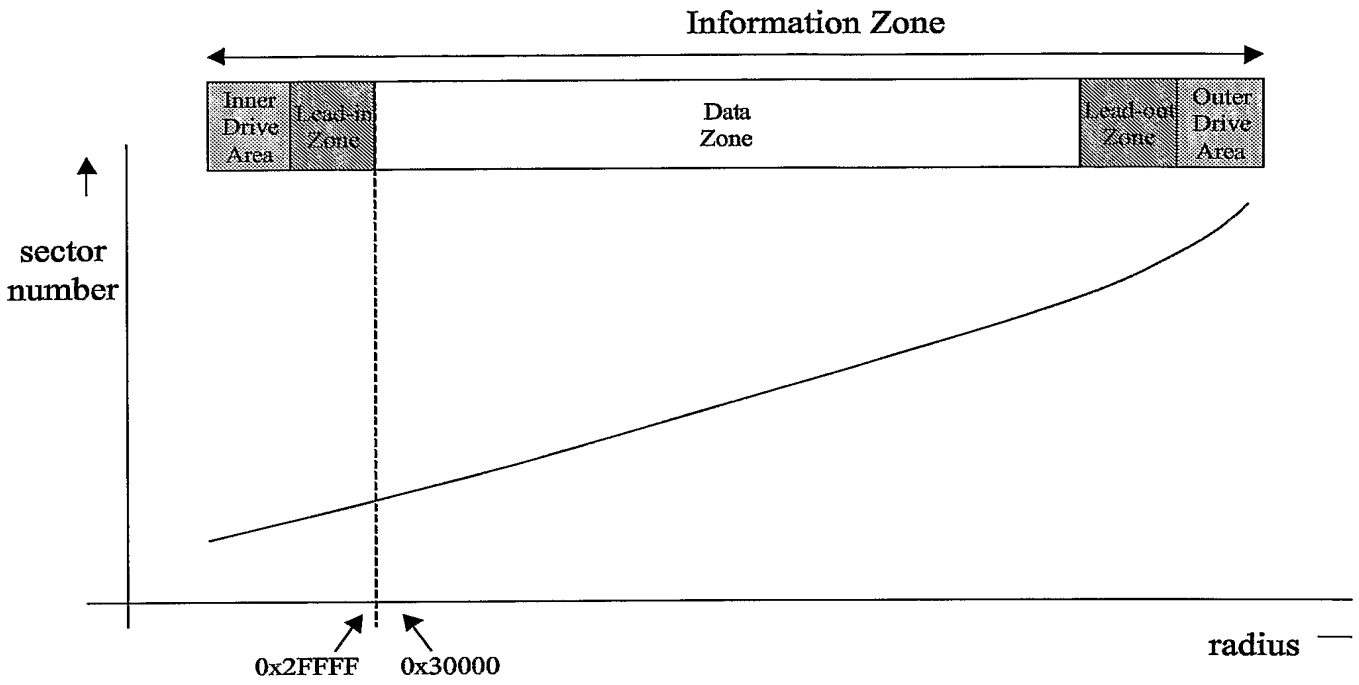

Figure 1 Lay-out of a typical DVD+RW or DVD+R disc

Figure 2 - Lay-out of a DVD+R disc

	Description	Nominal radius in mm	PSN of the first Physical Sector	Number of Physical Sectors
Inner Drive Area	Initial Zone	start 22,000 mm	--	blank
	Inner Disc Test Zone	start 22,643 mm	(023480)	16 384
	Inner Disc Count Zone	start 23,079 mm	(027480)	4 096
	Inner Disc Administration Zone	start 23,186 mm	(028480)	4 096
	Table of Contents Zone	start 23,293 mm	(029480)	4 096
Lead-in	Guard Zone 1	start 23,400 mm	(02A480)	14 848
	Reserved Zone 1		(02DE80)	4 096
	Reserved Zone 2		(02EE80)	64
	Inner Disc Identification Zone		(02EEC0)	256
	Reserved Zone 3		(02EFC0)	64
	Reference Code Zone	start 23,896 mm	(02F000)	32
	Buffer Zone 1		(02F020)	480
	Control Data Zone		(02F200)	3 072
	Buffer Zone 2		(02FE00)	512
Data	Data Zone	start 24,000 mm	(030000)	2 295 104 max
Lead-out	Buffer Zone 3	start 58,000 mm max	(260540) max	768
	Outer Disc Identification Zone		(260840) max	256
	Guard Zone 2		(260940) max	4096 min
Outer Drive Area	Outer Disc Administration Zone	start 58,053 mm	(261940)	4096
	Outer Disc Count Zone	start 58,096 mm	(262940)	4096
	Outer Disc Test Zone	start 58,139 mm	(263940)	16 384
	Guard Zone 3	start 58,310 mm	(267940)	blank

Figure 3 - Lay-out of a DVD+RW disc

	Description	Nominal radius in mm	PSN of the first Physical Sector	Number of Physical Sectors
Lead-in	Initial Zone	start 22,000 mm	(01D830)	52 304 nominal
	Inner Disc Test Zone	start 23,400 mm	(02A480)	2 048
	Inner Drive Test Zone		(02AC80)	12 288
	Guard Zone 1		(02DC80)	512
	Reserved Zone 1	start 23,782 mm	(02DE80)	4 096
	Reserved Zone 2	start 23,886 mm	(02EE80)	64
	Inner Disc Identification Zone		(02EEC0)	256
	Reserved Zone 3		(02EFC0)	64
	Reference Code Zone	start 23,896 mm	(02F000)	32
	Buffer Zone 1		(02F020)	480
	Control Data Zone		(02F200)	3 072
	Buffer Zone 2		(02FE00)	512
Data	Data Zone	start 24,000 mm	(030000)	2 295 104
Lead-out	Buffer Zone 3	start 58,000 mm	(260540)	768
	Outer Disc Identification Zone		(260840)	256
	Guard Zone 2		(260940)	4096
	Reserved Zone 4	start 58,053 mm	(261940)	4096
	Outer Drive Test Zone		(262940)	12 288
	Outer Disc Test Zone		(265940)	2 048
	Guard Zone 3	start 58,246 mm end ≥ 58,500 mm	(266140)	24 400 nominal